WHAT IS CLAIMED IS:

1. A gallium nitride (GaN) based light emitting diode (LED), wherein light is extracted through a nitrogen face (N-face) of the LED and a surface of the N-face is roughened into one or more cones.

2. The GaN LED of claim 1, wherein the cones are hexagonal shaped cones.

3. The GaN LED of claim 1, wherein the roughened surface reduces light reflections occurring repeatedly inside the LED, and thus extracts more light out of the LED.

4. The GaN LED of claim 1, wherein the surface of the N-face is roughened by an anisotropic etching.

5. The GaN LED of claim 4, wherein the anisotropic etching is a dry etching.

6. The GaN LED of claim 4, wherein the anisotropic etching is a photo-enhanced chemical (PEC) etching.

7. The GaN LED of claim 1, wherein the N-face is an n-type layer of the GaN LED.

8. The GaN LED of claim 1, wherein the N-face GaN is prepared by a laser lift off (LLO) technique.

9. The GaN LED of claim 1, wherein the LED is grown on a c-plane GaN wafer and a gallium face (Ga-face) is a p-type layer.

10. The GaN LED of claim 1, wherein the LED is comprised of an n-type electrode, n-type layer, active region, p-type layer and p-type electrode.

11. The GaN LED of claim 10, wherein the n-type layer, active region and p-type layer are each comprised of a (B, Al, Ga, In)N alloy.

12. The GaN LED of claim 10, wherein the p-type electrode has a property of high reflection to decrease light absorption and to increase light reflection toward the surface of the n-type layer.

13. The GaN LED of claim 10, wherein the LED includes a current-blocking layer aligned under the n-type electrode to keep the current from concentrating below the n-type electrode, so that absorption of light emission under the n-type electrode can be avoided and extraction efficiency can be increased.

14. The GaN LED of claim 10, wherein the LED includes a current-confining frame made of an insulator to restrain leakage current through the sidewalls of the LED without significantly decreasing an emitting area.

15. The GaN LED of claim 1, wherein the roughened surface is comprised of a plurality of hexagonal shaped cones that have an angle equal to or smaller than:

$$2\sin^{-1}(n_{air}/n_s) \approx 47.2^\circ$$

for GaN, where n_{air} is a refractive index of air and n_s is a refractive index of GaN.

16. The GaN LED of claim 1, wherein the roughened surface is comprised of a plurality of hexagonal shaped cones that have an angle equal to or smaller than:

$$2\sin^{-1}(n_{enc}/n_s)$$

for epoxy, where n_{enc} is a refractive index of epoxy and n_s is a refractive index of GaN.

17. A method of creating a gallium nitride (GaN) based light emitting diode (LED), wherein light is extracted through a nitrogen face (N-face) of the LED, comprising:

roughening a surface of the N-face into one or more cones.

18. A light emitting diode (LED) comprised of an n-type electrode, n-type layer, active region, p-type layer and p-type electrode, wherein a surface of the n-type layer is roughened by an anisotropic etching into one or more cones and light is extracted through the roughened surface of the n-type layer.

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1. A gallium nitride (GaN) based light emitting diode (LED), wherein light is extracted through a nitrogen face (N-face) of the LED and a surface of the N-face is roughened.

2. The GaN LED of claim 1, wherein the surface of the N-face is roughened into one or more cones.

3. The GaN LED of claim 1, wherein the roughened surface reduces light reflections occurring repeatedly inside the LED, and thus extracts more light out of the LED.

4. The GaN LED of claim 1, wherein the surface of the N-face is roughened by an anisotropic etching.

5. The GaN LED of claim 4, wherein the anisotropic etching is a dry etching.

6. The GaN LED of claim 4, wherein the anisotropic etching is a photo-enhanced chemical (PEC) etching.

7. The GaN LED of claim 1, wherein the N-face is an n-type layer of the GaN LED.

8. The GaN LED of claim 1, wherein the N-face is prepared by a laser lift off (LLO) technique.

9. The GaN LED of claim 1, wherein the LED is grown on a c-plane GaN wafer and a gallium face (Ga-face) is a p-type layer.

10. The GaN LED of claim 1, wherein the LED is comprised of an n-type electrode, n-type layer, active region, p-type layer and p-type electrode.

11. The GaN LED of claim 10, wherein the n-type layer, active region and p-type layer are each comprised of a (B, Al, Ga, In)N alloy.

12. The GaN LED of claim 10, wherein the p-type electrode has a property of high reflection to decrease light absorption and to increase light reflection toward the surface of the n-type layer.

13. The GaN LED of claim 10, wherein the LED includes a current-blocking layer aligned under the n-type electrode to keep the current from concentrating below the n-type electrode, so that absorption of light emission under the n-type electrode can be avoided and extraction efficiency can be increased.

14. The GaN LED of claim 10, wherein the LED includes a current-confining frame made of an insulator to restrain leakage current through the sidewalls of the LED without significantly decreasing an emitting area.

15. The GaN LED of claim 2, wherein the roughened surface is comprised of a plurality of hexagonal shaped cones that have an angle equal to or smaller than:

$$2\sin^{-1}(n_{air}/n_s) \approx 47.2^{\circ}$$

for GaN, where n_{air} is a refractive index of air and n_s is a refractive index of GaN.

AMENDED SHEET (ARTICLE 19)

16. The GaN LED of claim 2, wherein the roughened surface is comprised of a plurality of hexagonal shaped cones that have an angle equal to or smaller than:

$$2\sin^{-1}(n_{enc}/n_s)$$

for epoxy, where n_{enc} is a refractive index of epoxy and n_s is a refractive index of GaN.

17. A method of creating a gallium nitride (GaN) based light emitting diode (LED), wherein light is extracted through a nitrogen face (N-face) of the LED, comprising:

roughening a surface of the N-face into one or more cones.

18. A light emitting diode (LED) comprised of an n-type electrode, n-type layer, active region, p-type layer and p-type electrode, wherein a surface of the n-type layer is roughened by an anisotropic etching into one or more cones and light is extracted through the roughened surface of the n-type layer.

AMENDED SHEET (ARTICLE 19)